MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

PPH0105 – MODERN PHYSICS & THERMODYNAMICS

(All sections / Groups)

07 MARCH 2016
2.30 p.m - 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages (excluding physical constant and formula list) with 6 Questions only.

2. Attempt **FIVE** out of **SIX** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Instructions: Answer any **FIVE** of the **SIX** questions in this section. Write your answers in the Answer Booklet.

Question 1

a. State the three methods of heat transfer. (3 marks)

b. Figure Q1b shows heating curve for water. State the heat involved in process (i) and (ii). (2 marks)

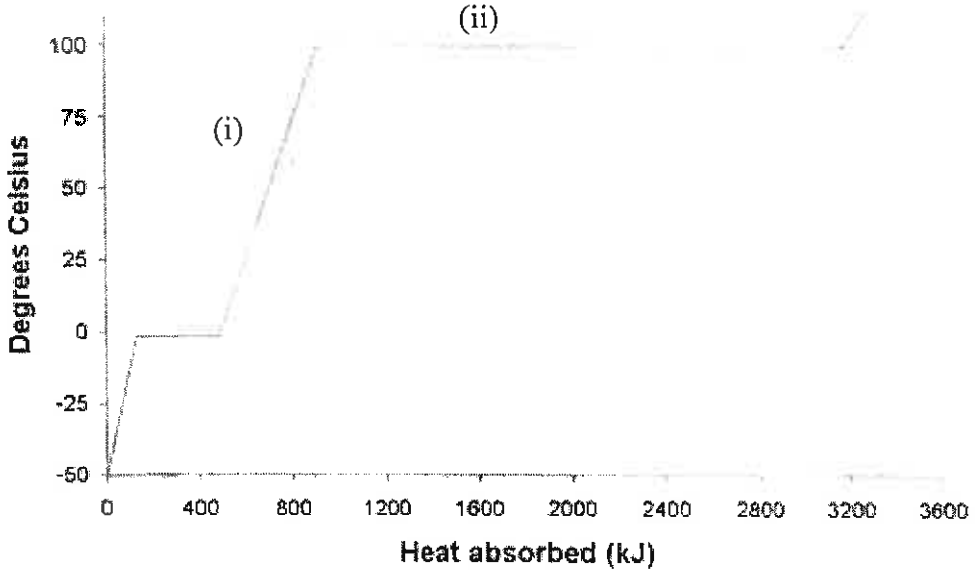

Figure Q1b

c. Standard temperature and pressure (STP) is defined as temperature of 0 °C and a pressure of 101.3 kPa. What is the volume occupied by one mole of an ideal gas at STP? (2 marks)

d. Figure Q1c shows the PV diagram for a gas. State the process (i), (ii) and (iii). (3 marks)

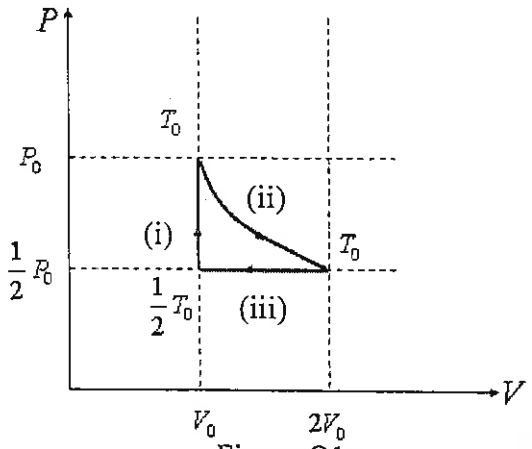

Figure Q1c

Continued...

Question 2

a. State the three types of radioactivity decay and the corresponding emitted particles. (3 marks)

b. The half-life of iodine-131, an isotope used in the treatment of thyroid disorders, is 8.04 days.

i. What is the decay constant for iodine-131? (2 marks)

ii. If a sample of iodine-131 contains 4.5×10^{16} nuclei, what is the activity of the sample? (2 marks)

c. Sketch the binding energy per nucleon curve. (1 mark)

d. Determine whether the following reactions are fission or fusion.

i. ${}_{0}^{1}n + {}_{92}^{235}U \rightarrow {}_{38}^{88}Sr + {}_{54}^{136}Xe + \text{neutrons}$ (1 mark)

ii. ${}_{1}^{1}H + {}_{3}^{7}Li \rightarrow {}_{4}^{7}Be + \text{neutron}$ (1 mark)

Question 3

a. Molybdenum has a work function of 4.20 eV. If the incident light has a wavelength of 180 nm, calculate

i. the maximum kinetic energy for the photoelectrons, (2 marks)

ii. the stopping potential. (2 marks)

b. Four possible transitions for a hydrogen atom are listed below:

I. $n_i = 2$; $n_f = 5$ II. $n_i = 5$; $n_f = 3$ III. $n_i = 7$; $n_f = 4$ IV. $n_i = 4$; $n_f = 7$

For which transition(s) does the atom

i. gain energy? (2 marks)

ii. lose energy? (2 marks)

c. The photons used in microwave ovens have a momentum of 5.1×10^{-33} kg·m/s. What is their wavelength? (2 marks)

Continued...

Question 4 [10 marks]

a. A layer of oil (n = 1.45) floats on an unknown liquid. A ray of light shines from the oil into the unknown liquid. The angles of incidence and refraction are, respectively, 65.0° and 53.0°. What is the index of refraction of the unknown liquid? (2 marks)

b. A converging lens (f = 100 cm) is placed 300 cm to the right of an arrow. A concave mirror (f = 50 cm) is placed 550 cm to the right of the arrow. Find the location of the final image formed by this system. (6 marks)

c. Light with a wavelength of 546 nm passes through two slits and forms an interference pattern on a screen 8.75 m away. If the linear distance on the screen from the central fringe to the first bright fringe above it is 5.16 cm, what is the separation of the slits? (2 marks)

Question 5 [10 marks]

a. At point A, 3.0 m from a small source of sound that is emitting uniformly in all directions, the sound intensity level is 53 dB.

   i. What is the intensity of the sound at A? (2 marks)

   ii. What is the power radiated? (2 marks)

b. Two loud speakers, A and B, are driven by the same amplifier and emit sinusoidal waves in phase. The frequency of the waves emitted by each speaker is 171.5 Hz. You are 8.00 m from A. What is the closest you can be to B and be at a point of destructive interference? (2 marks)

c. i. A sound source producing 1.00-kHz waves moves toward a stationary listener at 171.5 m/s. What frequency will the listener hear? (2 marks)

   ii. Suppose instead that the source is stationary and the listener moves toward the source at 171.5 m/s. What frequency does the listener hear? (2 marks)

Continued...

Question 6 [10 Marks]

a. A wave has a displacement (in meters) of $D = (0.45) \sin (\pi x + 8.0\pi t)$, where x and t are expressed in meters and seconds, respectively. Find

   i. the wavelength (2 marks)

   ii. the frequency (2 marks)

b. A stretched rubber has a length of 0.10 m and a fundamental frequency of 440 Hz. What is the speed at which waves travel on the rubber band? (2 marks)

c. A tube with a cap on one end, but open at the other end, produces a standing wave whose fundamental frequency is 171.5 Hz. The speed of sound is 343 m/s.

   i. How long is the tube? (2 marks)

   ii. If the cap is removed, what is the new fundamental frequency? (2 marks)

End of Paper

Physical Constants

Acceleration due to gravity	g	=	$9.8\ \text{m s}^{-2}$
Speed of Sound in Air	v	=	$343\ \text{m s}^{-1}$
Speed of light in vacuum	c	=	$3 \times 10^{8}\ \text{m s}^{-1}$
Threshold of hearing	I_o	=	$1.0 \times 10^{-12}\ \text{W m}^{-2}$
Coulomb constant	k	=	$9.0 \times 10^{9}\ \text{N m}^{2}\ \text{C}^{-2}$
Electronic charge	e	=	$1.602 \times 10^{-19}\ \text{C}$
Electron mass	m_e	=	$9.11 \times 10^{-31}\ \text{kg}$
Proton mass	m_p	=	$1.6726 \times 10^{-27}\ \text{kg}$
Neutron mass	m_n	=	$1.6749 \times 10^{-27}\ \text{kg}$
Refractive index of air/vacuum	n	=	1.0
Wein's displacement constant		=	$0.2898 \times 10^{-2}\ \text{m.K}$
Planck's constant	h	=	$6.626 \times 10^{-34}\ \text{J. s}$
Rydberg constant	R_H	=	$1.097 \times 10^{7}\ \text{m}^{-1}$
Avogadro's Number	N_A	=	$6.02 \times 10^{23}\ \text{mol}^{-1}$
Unified atomic mass unit	1 u	=	$1.66 \times 10^{-27}\ \text{kg}$
	1 eV	=	$1.602 \times 10^{-19}\ \text{J}$
Threshold of intensity of hearing	I_o	=	$1.0 \times 10^{-12}\ \text{Wm}^{-2}$
Stefan-Boltzmann constant	σ	=	$5.67 \times 10^{-8}\ \text{J s}^{-1}.\text{m}^{-2}.\text{K}^{-4}$
Universal gas constant	R	=	$8.31\ \text{J mol}^{-1}\ .\ \text{K}^{-1}$
Boltzmann's constant	κ	=	$1.38 \times 10^{-23}\ \text{J K}^{-1}$
	1 atm	=	$1.013 \times 10^{5}\ \text{Pa}$

The energy equivalent of the atomic mass unit is 931.5 MeV

Formula List

$\sin\theta_1 + \sin\theta_2 = 2\sin ½(\theta_1 + \theta_2)\cos ½(\theta_1 - \theta_2)$

$\cos\theta_1 + \cos\theta_2 = 2\cos ½(\theta_1 + \theta_2)\cos ½(\theta_1 - \theta_2)$

$\sin\left(\theta + \frac{\pi}{2}\right) = \cos\theta$

$\sin\theta \approx \tan\theta \approx \theta$ *rad* for small angle

$D(x, t) = D_M \sin(kx \pm \omega t \pm \phi)$

$v = \sqrt{\frac{F_\tau}{\mu}}$ $\quad$ $v = \sqrt{\frac{\text{elastic property of the medium}}{\text{inertia property of the medium}}}$

$\lambda_n = \frac{2}{n}L$ $\quad$ $f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right)$

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$ $\quad$ $\frac{1}{f} = (n-1)\left\{\frac{1}{R_1} + \frac{1}{R_2}\right\}$

$d\sin\theta = m\lambda$ $\quad$ $d\sin\theta = \left(m + \frac{1}{2}\right)\lambda$

$\lambda_m . T = 0.2898 \times 10^{-2}$ $\quad$ $I(\lambda, T) = \frac{2\pi c k_B T}{\lambda^4}$

$E_n = -\frac{mk^2e^4}{2\hbar^2}\left(\frac{1}{n^2}\right)$ $\quad$ $r_n = \frac{\hbar^2}{mke^2}n^2$ $\quad$ $L = mvr_n = n\hbar$

$\frac{1}{\lambda} = R_H\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]$ $\quad$ $\frac{1}{\lambda} = \frac{mk^2 Z^2 e^4}{4\pi c\hbar^3}\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$ $\quad$ $\lambda = \frac{h}{p}$

$R = R_0 e^{-\lambda t}$ $\quad$ $\lambda = \frac{\ln 2}{T_{\frac{1}{2}}}$ $\quad$ $Q = (M_X - M_Y - M_\alpha)\,c^2$

$pV = nRT$ $\quad$ $k = \frac{R}{N_A}$

$\frac{\Delta Q}{\Delta t} = -kA\frac{\Delta T}{\Delta L}$ $\quad$ $\frac{\Delta Q}{\Delta t} = e\sigma AT^4$ $\quad$ $\frac{\Delta Q}{\Delta t} = IeA\cos\theta$

$\overline{\text{KE}} = \frac{1}{2}m\bar{v}^2 = \frac{3}{2}kT$ $\quad$ $U = \frac{3}{2}nRT$

$Q = \Delta U + W$ $\quad$ $W = \int dW = \int_{V_i}^{V_f} P\,dV$